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Benjamin F. Shepherd
A Builder in Metals
(See article, p. 4)

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September, 1960

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METALS REVIEW

The News Digest Magazine

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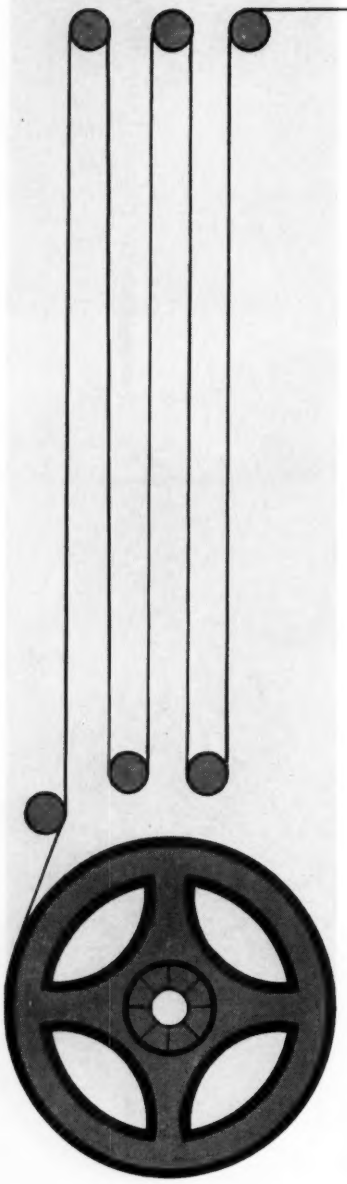

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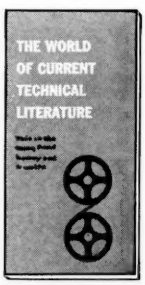

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METALS REVIEW

The News Digest Magazine

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Benjamin Franklin Shepherd
A Builder in Metals

In the dramatic new American Society for Metals headquarters building, a room is set aside for meetings of the Society's Board of Trustees. And in this room, on panels of Canadian birch, are mounted the photographs of some 40 past presidents of the A.S.M. and its forerunner, the American Society for Steel Treating.

If you chance by this room, open the panels, count three over from top left and four down. You'll be pointing to a picture of Benjamin F. Shepherd—a man who has contributed immeasurably to the world of metals symbolized by the building of metals.

June 30, 1960, holds doubled significance for B. F. Shepherd. That was the date of his retirement as chief metallurgist of Ingersoll-Rand Co., Phillipsburg, N.J. And on another June 30, exactly 49 years before, Ben Shepherd had first entered the doors of Ingersoll-Rand as a mail clerk, fresh out of Phillipsburg High School.

Forty-nine years with one company is indeed an accomplishment. Yet, in the case of Ben Shepherd, the mere longevity of service is far overshadowed by the singularly fruitful use he has made of his 49-year career. For this former company mail clerk has so distinguished himself that *Metal Progress* magazine calls him one of the "eminent living metallurgists". Dr. Shepherd (Lafayette College conferred upon him the honorary degree of Doctor of Science in 1955), served as national president of the American Society for Metals in 1935, and was presented one of the Society's highest honors, the Albert Sauveur Achievement Award, in 1942 for "pioneering achievement" in metallurgy.

And pioneer metallurgist he certainly is. He originated a major concept of "hardenability" of steels. His "Shepherd standards" for grading steels for fineness of fracture are universally applied. He even coined a new word for an old heat treating process which he resurrected from the early days of metallurgy and placed on a scientific basis. The word and the process—"Martempering"—are now internationally used.

Another Ben Shepherd "first" was the illustrating of the flow of metal in molds by motion pictures. One of his most recent developments, and an example of the versatility of his talents, is a new bronze alloy and method of treatment, now being used on pumps for nuclear submarines.

His memberships in technical and professional societies are many. In the A.S.M. alone, he has served as chairman of the Lehigh Valley Chapter, national trustee, national president, member of the national advisory council, conferee to the first and second World Metallurgical Congresses, and numerous committees. He is also an Honorary Life Member of the Society.

In saluting him, *Metal Progress* magazine said some years ago: "Benjamin Franklin Shepherd has much in his life that is reminiscent of the Colonial scientist he was named after". He learned metallurgy by experiencing it, reading about it, experimenting with it, talking about it with other metallurgists, and then contributing to it as only a select and distinguished group of others have ever done. He had no formal "education". Yet he has discovered and developed processes which are taught today in college classrooms around the world.

If metals are the bread of Ben Shepherd's life, minerals are his cake. His hobby is working with minerals of all types, polishing and shaping them into spheres. He even fashions them into unique and beautiful bracelets, cuff links and other jewelry. Yes, he does the silverwork, too.

Some of the more than 150 spheres he has polished, up to 6 in. in diameter, are in the American Museum of Natural History in New York. Some 30 others are displayed at Lafayette College. The balance he has presented, along with his extensive mineral collection, to the institution which represents his starting point—Phillipsburg High School. His objective in doing this, as he explains it, is "stimulation of the high-school generation into an appreciation of the beauty of minerals, and also the practical study of geology".

No question about it; Benjamin Franklin Shepherd has *given* metallurgy a great deal more than he's ever taken. Ingersoll-Rand, the American Society for Metals and the entire metallurgical profession can be proud to claim him.

Metals Review is equally proud to salute him, a past president of the A.S.M., upon his retirement and stands ready to report on the future accomplishments and contributions to metallurgy bound to come from this remarkable man.

Means of Preventing Electrochemical Corrosion

MOST COMMON STRUCTURAL metals occur in nature in the form of chemical compounds and are converted to metal by chemical or electrochemical means. On exposure to a natural environment the metals tend to revert to their natural state, by either chemical or electrochemical reactions, and this process of reversion is called corrosion, according to M. Cohen, National Research Council of Canada, who spoke at a meeting in Ontario.

Most corrosion in aqueous solutions takes place by an electrochemical mechanism by which metal is dissolved at anodic areas accompanied by an electron reduction reaction at cathodic areas. Corrosion is accelerated by those effects which increase the rate of either the cathodic or anodic reaction and is slowed down by factors which suppress these reactions.

Oxygen in aqueous solutions increases the rate of corrosion through the cathodic reaction. It is also associated with corrosion due to faulty design wherein oxygen-depleted crevices abut large areas exposed to oxygen-rich solutions. Electrochemical corrosion is also very often stimulated by the presence of dissimilar metals in contact with each other or the same metal in different physical states.

Corrosion in aqueous systems can be prevented or largely decreased by suppressing either anodic or cathodic reactions by adding inhibitors to the solution. Organic materials are usually used in acid solutions in the form of large molecules containing oxygen, sulphur or nitrogen, which adsorb strongly on the surface and act as a shield between the metal and the acid. In neutral or basic solution inorganic materials are used and these help form a thin protective oxide film over the whole metal surface. An insufficient amount of inorganic inhibitor can lead to the formation of defective oxide films and subsequent pitting. Certain ions, such as chloride or sulphate, tend to break down the protective oxide films and initiate corrosion.

Aqueous corrosion can also be prevented by electrochemical means, such as cathodic protection, where the specimen is made a cathode by connection to either a highly anodic metal such as magnesium or zinc or by an applied d-c. current. Cathodic protection can be used to protect metals immersed in solutions or wet soils.

In the last few years some metals, particularly iron and stainless steels, have been protected by anodic polarization. The metal is made the anode in a system at such a potential that the formation of a protective oxide film becomes the most favored process. Once the film has been formed, the current required to maintain passivity becomes extremely low, in some cases as low as 1 microampere per square decimeter. The protective films formed by both inorganic inhibitors and anodic treatment are usually less than one-millionth of an inch thick.

At higher temperatures much thicker films and scales are formed, in which cases corrosion takes place by diffusion of either oxygen or metal ions through the film. The prevention of corrosion or oxidation is brought about by changing the diffusion properties of the films or scales. This is usually accomplished by the addition of alloying materials to the metal or by pretreatments which change the composition of the surface of the metal. The addition of chromium to iron leads to a high chromium scale with a changed crystallographic nature. Some alloying additions, such as molybdenum or vanadium, for example, actually increase the rate of oxidation because of the formation of volatile oxides. Further developments in high-temperature resistant material will come with a better understanding of both the chemical and physical properties of the oxides which are formed. *(Reported by J. S. Kirkaldy.)*

Automation in the Metals Industry

MARVIN E. MURPHY, APPLICATION engineer, General Electric Co., in reviewing the progress of "Automation in the Metals Industry", at Upper Ohio Valley Chapter, stated that the application of automation techniques fits a pattern that is almost universally suited to any process, and our experience has shown it to be especially applicable to the metals industries.

To understand the many potential benefits of the automated system one must understand the pattern known as the automation ring, which Mr. Murphy explained as the technical tool to illustrate the relations of various components of the process system to one another.

There is a significant difference between successful operation and optimum operation. In years past, with the aid of a few sensors and the power converting and actuating elements associated with a process, an operator could manually control production—but only within the limits of human perception, speed and intelligence. Continuous monitoring for process errors as small as 1/10% and correcting in a fraction of a second is obviously not an assignment for the human mechanism. Something automatic is needed, a need ably filled by the modern-day feedback control system.

In steel mills two excellent future applications for using process computer control and programming are the continuous annealing line and the continuous trinning line. *(Reported by R. L. LeVaughn.)*

Why Metal Parts Fail . . . . Series Speaker Offers Solutions

An understanding of why machine parts fail will permit designs with lower factors of safety, according to Charles A. Lipson, professor of mechanical engineering, University of Michigan, who conducted a series of three educational lectures covering various aspects of metal parts failure before the Detroit Chapter.

In opening the series, Prof. Lipson analyzed failures in several types of parts including crankshafts, camshafts, axle shafts and gears. The progression of metal fatigue from its origin, through the bench-marks to the final part failure, was traced on typical automotive parts. Plastics prototypes, stress analyzed with polarized light, exposed the offending notch which caused the failure. Stress-relief notches, properly placed, provided the solution to the problems of this type of failure, according to the lecturer.

Prof. Lipson's second lecture was devoted primarily to fatigue. In determining the suitability of a design, he pointed out, the part should be evaluated for those factors which are considered important in its specified operation, such as resistance to static loads, impact, deflection, fatigue, heat and corrosion.

In discussing fatigue, Prof. Lipson pointed out that the relationship of fatigue strength to tensile strength differs between ferrous and nonferrous materials, but follows a definite pattern for each category of material. He then elaborated upon factors affecting the fatigue strength of steel products.

An equation was devised in which eight factors were considered which, if properly evaluated, would determine the significant fatigue strength of any given part. Depending upon the set of conditions involved, it would be possible to have the fatigue strength of a part as low as 10% of the tensile strength of the basic materials or as high as 90%. High fatigue strengths are attained by such special surface treatments as shot peening, case hardening and cold rolling.

Although the equation developed can indicate the relative importance of the conditions involved in the applications of parts, it does not give a completely true picture. Thus, it is important that critical parts be subjected to actual fatigue tests which duplicate as closely as possible actual service conditions when proving out a new design.

The final lecture in the series covered "Analysis and Remedies", and was primarily concerned with several methods used for expressing the so-called "factor of safety".

The factor of safety index is expressed in a satisfactorily designed part as a ratio which reveals a proper balance between the significant stress and the significant strength. Thus a reliable method for predicting the balance between stress and strength of a member, with which the designer has little or no experience, requires that all factors effecting the stress and strength be considered individually. The resulting balance must allow for a factor of safety which will be much smaller since it will have to provide for occasional overloading, production and service, type of loading, size effect, surface finish, surface treatment, life expectancy and mode of loading.

Recently, a new concept, called a functional reserve factor, has been introduced to link factor of safety and "part" strength. A functional reserve factor is defined as the ratio of the magnitude of a variable producing a failure to the value of the variable at operating conditions. It was stated that it is quite apparent that the concept of functional reserve factor, if ever fully developed and accepted, could become an important tool in machine design.

In the past, many factors of safety were obtained through experience on members which exhibited no failure when designed from these conventionally large safety factors. However, these large factors were obtained by lumping together all the effects of loading and service conditions about which little was known. Consequently, these often resulted in gross overdesign with safety factor range in magnitude from 5 to 20. Such large safety factors should not be used in machine design where the loads fluctuate in a definite manner.

The exact meaning of the factor of safety can best be expressed by the following equation:

$$\text{Factor of Safety} = \frac{\text{Significant Strength}}{\text{Significant Stress}}$$

The significant strength is the actual maximum strength which a member possesses without failing. The significant stress is the actual stress existing in a member. This is determined by computing the nominal stresses in a member and then correcting these by applying stress concentration factors which have been determined from the type of stress raiser and the notch

sensitivity of the material.

Dr. Lipson pointed out that factor of safety does not necessitate that stress and strength be expressed in terms of psi. For example, in gears the strength is expressed in terms of tooth strength F_s which is the maximum allowable force in pounds which could be applied to the tooth without causing fracture.

The decision as to whether a given safety factor is adequate must be determined for each design because each member is essentially an individual problem. Safety factors as low as 1.3 represent adequate insurance against failure. However, for moderate overloads a safety factor in the region of two is generally used.

COMPLIMENTS

To HUGH L. LOGAN, a physicist with the Corrosion Section of the National Bureau of Standards, who received the Dept. of Commerce Silver Medal for Meritorious Service. He was cited for "exceptional achievement in metallurgy, particularly in researches into the stress corrosion cracking of metals and for meritorious authorship".

To CAROLYN R. IRISH, a metallurgist in the Thermal Metallurgy Section of the National Bureau of Standards, who also received a Dept. of Commerce Silver Medal for her "extremely competent and conscientious work in the field of physical metallurgy for many years". Mrs. Irish is currently engaged in research on steels capable of structural application in aircraft at high strength levels and elevated temperatures.

To DUDLEY WILLIS ROCKWELL, who has been named president of the Stanley P. Rockwell Co., Hartford, Conn., to succeed the late William A. Stumpf. Mr. Rockwell is the son of the founder of the company, Stanley P. Rockwell, inventor of the Rockwell Hardness Tester.

To MANLEY E. BROOKS, who received the 1960 David Ford McFarland Award for Achievement in Metallurgy, established in 1949 as an annual recognition to a metallurgy alumnus of the Pennsylvania State University by the Penn State Chapter A.S.M. Mr. Brooks is a consultant and foundry engineer in the magnesium department, Dow Chemical Co.

To SAMUEL J. ROSENBERG, metallurgist at the National Bureau of Standards, and to IRVING B. CADOFF, department of metallurgical engineering, New York University, on being made honorary members of the national honorary metallurgical fraternity, Alpha Sigma Mu.

Advantages of Titanium In Competition Over Stainless

Walter L. Finlay, director of research, Crucible Steel Co. of America, gave a talk on "Titanium and Competitive Stainless Steels" at Washington.

Dr. Finlay discussed many of the physical, mechanical and corrosion properties that make titanium and titanium-base alloys so attractive. Some of the specific applications included the increased use of titanium in missiles and rocket planes. The Atlas missile employs about 4% and the X-15 rocket plane about 17.5% titanium by weight. In some commercial aircraft, such as the DC-8, 330 lb. of Ti-Al-V alloy replaces 945 lb. of other material. This net decrease in weight is the equivalent of five additional passengers and their baggage.

The excellent corrosion resistance of titanium and its alloys were further exemplified by its application as condenser tubing in contact with nitric acid and its life expectancy of 30 to 1 over stainless steel, and its use in prosthetics, particularly ball and socket hip joints.

The increased use of titanium in missiles was not alone due to low density. Certain of the alloys, such as A 110 AT, have excellent cryogenic properties, which make them a natural material for pressure vessels holding liquefied gases.

Dr. Finlay pointed out that strength-to-weight ratio is not always the entire answer in evaluating materials. Buckling must also be considered. In this respect, on a plot of crippling index as a function of temperature, titanium is best from 400-1100°F., between aluminum and Inconel at low compressive loading, and best at all temperatures up to 1100°F. at high compressive loading.

Though titanium appears in many cases to cost more than other materials, the speaker pointed out that when service life (corrosion) or added payload (aircraft) are considered, the use of titanium may be quite comparable to less expensive materials from a cost standpoint.

In summary, Dr. Finlay pointed out that all materials would be needed to keep up with the advances in the 1960's. Now that titanium and its alloys are attaining a more senior status they will be joining the team of the commonly used materials in assisting in this rapid technological advance. *(Reported by Eugene Tsao.)*

METALLURGICAL NEWS AND DEVELOPMENTS

GRAPHITE-BASE MATERIAL

Boeing Airplane engineers have developed an experimental ceramic graphite-base material which spontaneously forms its own protective coating. A typical composition is one containing 50% graphite, 24% molybdenum disilicide and 25% titanium boride, plus bonding agents. In considering materials of this type for possible use in space vehicles and for other high-temperature use, engineers believe they will provide strengths in tension and compression that are about double those provided in standard graphite.

ALUMINUM GRAIN SIZE CONTROL

Grain refinement in aluminum casting alloys is now being achieved through use of carbon tetrachloride introduced into the melt by means of nitrogen as a carrier gas. The refinement process is best suited to aluminum alloys containing from 2-8.5% magnesium, plus small amounts of boron and titanium. The carbon tetrachloride treatment makes possible 10 to 15% better tensile strength, 25% better elongation and substantially improved machinability. Strength is improved particularly at high temperatures. One of the projected uses of the fine-grained cast alloys is in automotive cylinder heads.

BERYLLIUM COPPER FORMING DIES

An aircraft company is using beryllium copper forming dies as a tooling material for hot forming many alloys used in making supersonic fighter planes. The materials, some of which require forming at temperatures as high as 1300°F., include titanium, molybdenum, some magnesium and aluminum alloys and refractory of high-melting point metals. In addition to high strength and other properties at elevated temperatures, the beryllium copper alloys have a high rate of heat conductivity. The materials are cast to close dimensional tolerances in ceramic molds and are said to require little surface finishing.

MAGNETIC PARTICLE INSPECTION

A new system for detecting defective welds, cracks, inclusions and other flaws in materials that can be inspected by magnetic particle systems is now available to industry. Known as Recordaflux, the inspection method is capable of determining, nondestructively, the diameter of spot welds in stainless steel. Key to the new system is a solution containing magnetic particles. When sprayed or poured on the surface of a part and a magnetic field applied, the magnetic particles migrate in the solution. The solution then sets up as a strippable plastic film with the particles frozen in place. Patterns in the film show the sizes and uniformity of welds and pinpoint flaws.

NOZZLES MADE BY PLASMA JET

A new technique for making rocket nozzles to extremely close tolerances in throat dimensions combines features of plasma jet technology and electroforming. The lining of the nozzle is plasma jet sprayed onto a rapidly spinning mandrel manufactured to the desired tolerances. The plasma jet sprayed material deposited on the mandrel conforms to the mandrel surface with extreme precision. Once the lining is deposited to the desired thickness, back-up layers of support metal can be electroformed to the liner and then the mandrel leached out. Typical is the first test nozzle in which a 0.030-in. thick lining of tungsten was deposited. Next, 0.100 in. of nickel was electrodeposited onto the liner to act as a support. A similar nozzle was heated to 2500°F. and dropped into cold water with no flaws or cracks developing.

HIGH STRENGTH WIRE

A new high-carbon steel wire is being produced with a tensile strength of 575,000 psi. The wire, being used initially in military applications, is available in 0.005-in. diameters and finer. Tensile strengths are somewhat lower in larger sizes. In its present applications, the wire is fabricated with plastics binders for form high-tensile members.

MECHANICAL PLATING

Plating for corrosion protection is now being achieved by a method identified as the Mechanical Plating System. Basically the new system involves the use of specially prepared plating

metal in powder form with special chemicals and impact media and water. The parts are placed in a rubber-lined tumbling barrel. Plating is accomplished in about 45 min. Thickness of the plate is controlled by the amount of plating metal in the solution. The process, in effect, cold welds the metals into dense, continuous and adherent coatings. One major advantage claimed for the new method is the complete elimination of hydrogen embrittlement. Another is that small metal parts and assemblies can be mass plated even though their design is such that difficulty might be experienced with other plating systems.

MATERIALS RESEARCH CENTERS

Northwestern University has established with the Advanced Research Projects Agency a new basic materials research center, one of three being planned for the immediate future. According to APRA, lack of materials meeting the high performance demands of the space age is a serious roadblock holding up the nation's weapons, atomic energy and space programs. Purpose of the new Materials Research Center is fundamental research into relationships between composition and structure and between properties and behavior of materials. Under study will be metals, semiconductors, plastics and ceramics. Morris E. Fine has been named chairman of the center. Other research centers will be operated at Cornell and the University of Pennsylvania.

GLASS FIBER FLAKE COATING

Flaked fiber glass, fine enough to be applied through special spray guns, is now available as a protective coating for metal surfaces. The corrosion-resistant coating is a homogeneous mixture of the flaked material, resin, fillers, accelerator and, if desired, pigment. The new coating can be used on chemical and oil storage tanks, industrial ducting and other applications where corrosion is a major problem.

CASTING STEELS RESIST ABRASION

Two new austenitic manganese steels have been developed to provide increased abrasion resistance in castings. Both are manganese-molybdenum alloys. One combines toughness, abrasion resistance and ductility. The other provides exceptional abrasion resistance but only moderate ductility. Increased molybdenum content in the steels permits a higher carbon content than is normal in Hadfield manganese steels. Developed by Climax Molybdenum Co., the steels will not be marketed, but information on their production will be made available by the company to interested organizations.

Cleaning the Atlas

A TALK ON THE FABRICATION and fuel storage complexes of the Atlas Missile and the phases necessary for complete cleaning of all material before installation into the complexes was given at Inland Empire Chapter by Lieutenant-Colonel James E. Benedict, chief, Field Office, Fairchild Air Force Base, Washington.

All engineering aspects of design which are compatible with the functional missile requirements to place the Atlas missile into the launching complex were discussed.

Lt. Col. Benedict also presented a film showing the teaching program of installation procedures covering cleaning, construction and installation of the Atlas Missile propellant loading system for the sites now under construction in the Spokane area. *(Reported by John W. King for Inland Empire).*

OBITUARIES

Earle C. Smith, chief metallurgist and research director, Republic Steel Corp., died late in May at the age of 69. Mr. Smith, an honorary member A.S.M., received the Society's Gold Medal in 1946 and was the Campbell Memorial Lecturer in 1950. (See *Metals Review,* November 1959, p. 4).

Angus G. Sturrock, chief metallurgist, Wyckoff Steel Co. since 1950, died July 1. He had been associated with Wyckoff for 31 years.

Dan Sisk, Chicago district sales engineer for Kolene Corp. of Detroit, died in April. He had been with Kolene since 1943.

Clifford Hurley, 67, an aeronautical engineer with the Navy Bureau of Aeronautics for 40 years, died recently in Washington after a short illness.

C. M. Johnson, retired chief chemist for Crucible Steel Co. of America, died at the age of 90. Mr. Johnson, who had been associated with the steel industry for 60 years, received A.S.M.'s Distinguished Service Award in 1948 for "the early perfection of analytical methods for chemical control of alloys in steel".

Norman I. Stotz, a 35-year member A.S.M., died Feb. 22, 1960, at the age of 66. He was a president of the Braeburn Alloy Steel Corp., a subsidiary of Continental Copper & Steel Industries, Inc., and a director and vice-president of the latter. Mr. Stotz, who is credited with development of the 5% chromium-molybdenum air hardening die steel, served as a conferee to both the First and Second World Metallurgical Congresses.

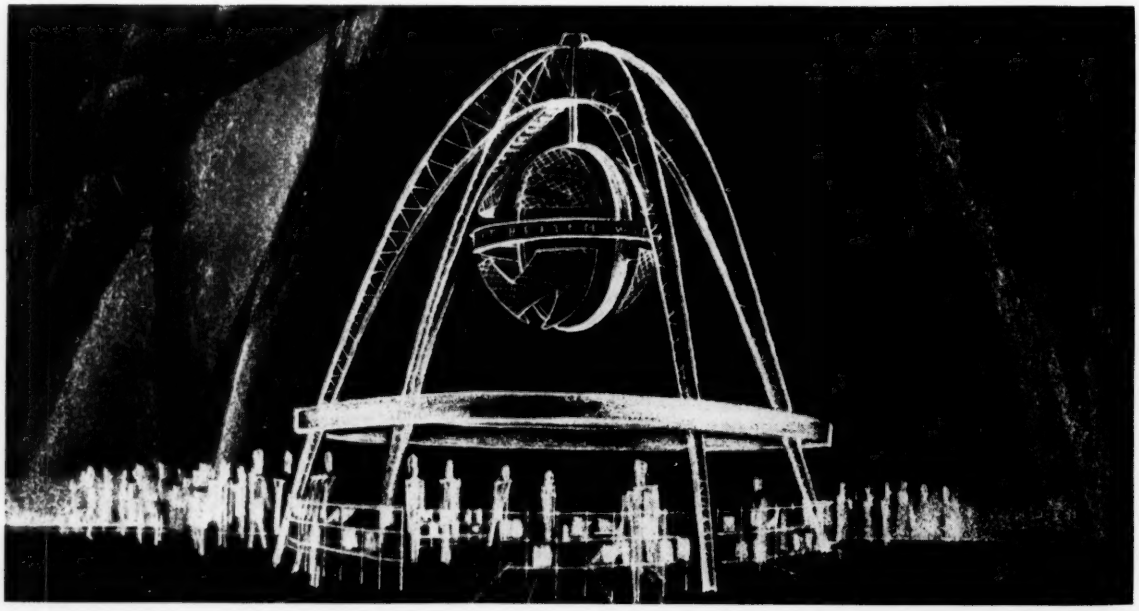
1960..... The New Metal Congress and Exposition

A.S.M. Seminar

All arrangements for the 1960 A.S.M. Seminar are now completed, according to Julius J. Harwood, Seminar coordinator. The subject of this year's Seminar is "Strengthening Mechanisms in Solids". A highlight of the program will be the appearance of Prof. J. Nutting of the University of Cambridge, England, who will deliver a paper on "Strengthening Mechanisms as Observed Directly by Electron Transmission Microscopy".

Seminar sessions are to be held in the Rose Garden of Bellevue-Stratford Hotel, Philadelphia, Oct. 15 and 16, the Saturday and Sunday preceding the opening of the National Metal Congress and Exposition. Papers scheduled for presentation are: "Introductory Review of Strengthening Mechanisms", W. R. Hibbard, Jr., General Electric Research Laboratory; "Solid-Solution Strengthening", P. A. Flinn, Westinghouse Research Laboratory; "Strengthening by Work Hardening", J. Washburn, University of California; "Strengthening Mechanisms as Observed Directly by Electron Transmission Microscopy", J. Nutting, University of Cambridge, England; "Radiation Hardening", G. H. Vineyard, Brookhaven National Laboratory; "Point Defect Hardening in Face-Centered Cubic Metal", R. Maddin, University of Pennsylvania; "Strengthening by Martensitic Transformations", V. F. Zackay, Ford Scientific Laboratory; "Strengthening by Precipitation Reactions", W. D. Robertson, Yale University; "Fine Particle Strengthening", R. W. Guard, General Electric Research Laboratory; "Hardening Effects Produced With Shock Waves", G. E. Dieter, E. I. duPont Engineering Research Laboratory; "Strengthening Mechanisms in Ionic and Inorganic Solids", T. L. Johnston, C. Li and R. Stokes, Minneapolis-Honeywell Research Center; and, "Role of Surface Effects in Strengthening Mechanisms", E. Machlin, Columbia University.

The "Steel Quadrilon", One of the Focal Points of the 1960 Philadelphia Metal Show. This 34-ft. high symbol of modern steel will provide a striking setting for the formal opening ceremonies of a dramatically different Metal Show, Oct. 17, at 11:00 a.m. Arrayed about the crossed arches of the quadrilon will be the exhibits of 16 of the nation's major steel firms. This "Steel Arena" represents a new departure in Metal Show dimension, color, technique and transportation



Awards Luncheon

EDWARD G. BUDD, JR., president of The Budd Co., Philadelphia, will be featured speaker at the 5th Annual Awards Luncheon of the American Society for Metals. Allan Ray Putnam, A.S.M. managing director, announced the event for Tuesday noon, Oct. 18, in the ballroom of the

Edward G. Budd, Jr.

Philadelphia Trade and Convention Center. Industry and civic leaders from Philadelphia and the entire nation will be invited to the luncheon.

The Awards Luncheon will be one of the highlights of the 1960 Philadelphia Metal Show and Congress. Putnam described the awards program as a direct effort by the A.S.M. to encourage improved technology in metals and materials.

Upon completion of his address, Mr. Budd will be awarded the Distinguished Life Membership in the American Society for Metals, an honor reserved for industry leaders who have made outstanding contributions to the progress of materials and processes. Other major awards of the Society also will be presented at the luncheon.

Mr. Budd started his apprenticeship with The Budd Co. in 1923. He worked as a tool and die maker and spent a year in Paris with Citroen, one of the first foreign licensees of the company. He returned to The Budd Co. late in 1925 and worked in the methods and equipment department. In 1929 he was made night superintendent. From late 1929 to 1934 he was director of purchases.

In 1934 he became general manager of the factory and a vice-president of the company. Four years later he was made a director, and in 1943 was elected executive vice-president. He became president in 1946, following the death of his father who founded the company in 1912. Under the creative leadership of Mr. Budd and his father, the company has over the years made numerous advances in research, production, design and testing processes in many areas of industry.

ASM Annual Meeting

THE ANNUAL MEETING of the American Society for Metals is scheduled for 9:00 a.m. Wednesday, Oct. 19, in the Grand Ballroom of the Bellevue-Stratford Hotel, Philadelphia, during the 42nd ASM National Metal Congress and Exposition.

Members of the Society are expected to attend from nearly every area of the United States and Canada where A.S.M.'s 114 Chapters are located.

Highlight of the Meeting will be the election and installation of A.S.M. national officers for 1960-1961. Three officers and two new trustees are to be selected. Reports from present officers will cover the activities and progress of the Society for the past year.

Three officers and trustees who are retiring from the Board will be honored during the Meeting. Walter Crafts, A.S.M. president for 1959-1960, will preside.

The Meeting will be followed immediately by the presentation of the annual Campbell Memorial Lecture.

Campbell Memorial Lecture

CLARENCE ZENER, NOTED PHYSICIST, will deliver the American Society for Metals' most honored technical presentation—the Edward de Mille Campbell Memorial Lecture—at the Society's 42nd National Metal Congress in Philadelphia. Dr. Zener is director of Westinghouse Research Laboratories, Pittsburgh.

The lecture will be presented at 11:00 a.m.,

Clarence Zener

Wednesday, Oct. 19, immediately following the A.S.M. Annual Meeting, in the Grand Ballroom of the Bellevue-Stratford Hotel. Dr. Zener has chosen as the subject of his lecture "Putting Electrons to Work". He will be the 35th Campbell Lecturer since the honor was established in 1925 at the suggestion of Albert Easton White, first A.S.M. president.

The Society will award Dr. Zener with a $500 honorarium and a sheepskin scroll in recogni-

tion of the achievements which effected his selection as principal technical speaker for 1960.

After receiving his undergraduate degree in 1926 from Stanford University, Dr. Zener earned a doctorate in physics in 1929 at Harvard. He has pursued an academic career, holding fellowships both in this country and abroad and teaching positions at Washington University, the City College of New York and Washington State College. During the war years he worked on projectile and armor plate at Watertown Arsenal. After the war he became a professor in the Institute of Metals and Department of Physics at the University of Chicago.

In 1951 he joined Westinghouse, becoming director of its Research Laboratories in 1956. He has worked in various phases of the physics of solids, including the electron theory of metals, electrical breakdown in semiconductors, internal friction and magnetism. He is a member of the American Physical Society and A.I.M.E.

Calendar of Events

Technical Sessions

Saturday, Oct., 15, 1960

a.m. A.S.M. Seminar—Strengthening Mechanisms in Solids—Bellevue-Stratford

p.m. A.S.M. Seminar—Strengthening Mechanisms in Solids—Bellevue-Stratford

Sunday, Oct. 16, 1960

a.m. A.S.M. Seminar—Strengthening Mechanisms in Solids—Bellevue-Stratford

p.m. A.S.M. Seminar—Strenghening Mechanisms in Solids—Bellevue-Stratford

Monday, Oct. 17, 1960

a.m. A.S.M. Technical Session — Physical Metallurgy—Bellevue-Stratford
A.S.M. Metals Engineering Program—Materials for the Aerospace Age—Bellevue-Stratford
A.S.M.-A.E.C. Conference — Nonoxide Compounds for Nuclear Fuels—Bellevue-Stratford
A.I.M.E. Technical Session—Hotel Sheraton
S.N.T. Technical Session—Hotel Benjamin Franklin

Noon Metal Show Opens

p.m. A.S.M. Technical Session — Physical Metallurgy—Bellevue-Stratford
A.S.M. Metals Engineering Program—Metals Joining—Bellevue-Stratford
A.S.M.-A.E.C. Conference — Nonoxide Compounds for Nuclear Fuels—Bellevue-Stratford
A.I.M.E. Technical Sessions — Hotel Sheraton
S.N.T. Technical Session—Hotel Benjamin Franklin

Eve. A.S.M. Chapter Chairman's Dinner — Bellevue-Stratford

Tuesday, Oct. 18, 1960

a.m. A.S.M. Technical Session—Steel I—Bellevue-Stratford
A.S.M. Technical Session—Phase Diagrams—Bellevue-Stratford
A.S.M. Metals Engineering Program—Failure Analysis—Bellevue-Stratford
I.H.E.A. Heat Treating Stainless Steels—Bellevue-Stratford
A.I.M.E. Technical Session—Hotel Sheraton
S.N.T. Technical Sessions—Hotel Benjamin Franklin

Noon A.S.M. Awards Luncheon

p.m. A.S.M. Technical Sessions—Steel II—Bellevue-Stratford
A.S.M. Technical Sessions—Plastic Deformation—Bellevue-Stratford
A.S.M. Metals Engineering Program—Failure Analysis—Bellevue-Stratford
A.I.M.E. Technical Sessions — Hotel Sheraton
S.N.T. Technical Sessions—Hotel Benjamin Franklin
A.S.M. Symposium for Steel Users—Stainless Steels—Convention Hall

Wednesday, Oct. 19, 1960

a.m. A.S.M. Annual Meeting—Bellevue-Stratford
A.S.M. Campbell Memorial Lecture—Bellevue-Stratford
A.I.M.E. Technical Sessions — Hotel Sheraton
S.N.T. Technical Session—Hotel Benjamin Franklin

Noon A.S.M. Alumni Luncheons

p.m. A.S.M. Technical Session—Steel III—Bellevue-Stratford
A.S.M. Technical Session—High-Temperature Materials—Bellevue-Stratford
A.S.M. Metals Engineering Program—Advances in Metallurgical Microscopy—Bellevue-Stratford
A.S.M. Symposium for Steel Users—Toolsteels—Convention Hall
A.I.M.E. Technical Sessions — Hotel Sheraton
S.N.T. Technical Session—Hotel Benjamin Franklin
Metal Powder Industries Federation Technical Session—Bellevue-Stratford

Thursday, Oct. 20, 1960

a.m. A.S.M. Technical Session—Nuclear Metals—Bellevue-Stratford
A.S.M. Metals Engineering Program—

Effects of Structures on Properties—Bellevue-Stratford
Metal Treating Institute Technical Session—Bellevue-Stratford
A.I.M.E. Technical Sessions — Hotel Sheraton
S.N.T. Technical Session—Hotel Benjamin Franklin
S.L.A. (Metals Division) Technical Session—John Bartram Hotel

p.m. A.S.M. Technical Session—Embrittlement—Bellevue-Stratford
A.S.M. Metals Engineering Program—Effects of Strucures on Properties—Bellevue-Stratford
A.I.M.E. Technical Sessions — Hotel Sheraton
S.N.T. Technical Session—Hotel Benjamin Franklin
Ultrasonics Mfrs. Association Technical Session
S.L.A. (Metals Division) Technical Session—John Bartram Hotel
A.S.M. Symposium for Steel Users—Joining High-Strength Steels—Convention Hall

Eve. A.S.M.. Annual. Banquet — Bellevue-Stratford

Friday, Oct. 21, 1960

a.m. and p.m. S.L.A. (Metals Division) Special Metals Engineering Institute Course I —John Bartram Hotel

Saturday, Oct. 22, 1960

a.m. and p.m. S.L.A. (Metals Division) Special M.E.I. Course II—John Bartram Hotel

Distinguished Service Luncheon

STANLEY H. NORWOOD, vice-president, Union Carbide Metals Co., will draw upon his long experience in the engineering field in speaking to future metals engineers of Philadelphia at the 1960 Philadelphia Metal Show, Friday noon, Oct. 21, 1960.

Norwood will address the Distinguished Service Luncheon, a high point of the annual Young Engineers Day observances at the Metal Show. Metallurgical engineering students in Philadelphia area colleges will be invited to join 25-year members of the American Society for Metals at the luncheon.

Young Engineers Day is one of the educational activities of the A.S.M. in its efforts to encourage the potential technical backbone of the nation in engineering pursuits. Young students are invited to the luncheon to discuss engineering on an informal basis with experienced metals engineers as represented by the 25-year A.S.M. members.

Norwood will discuss the opportunities, challenges and problems confronting the young engineer already engaged in the industry, reflecting on his own long and successful experience in the field.

Following the luncheon, the students will have an opportunity to observe the latest engineering advances in materials and processes as demonstrated at the Metal Show.

Stainless Steel Panel

DOWN-TO-EARTH, PRACTICAL INFORMATION on stainless steels is the promise of a special panel of experts in the fabrication of stainless steels at the National Metal Congress in Philadelphia. The panel will occupy a major portion of the Stainless Steel Session of the Symposium for Steel Users. The session is scheduled for 2:00 p.m., Tuesday, Oct. 18, and will be held in the Ballroom of Convention Hall.

Individuals seeking information on any phase of stainless steel fabrication are invited to submit questions in advance. For that purpose, a coupon is included on this page. Prepare your question, send it to A.S.M. Headquarters and then come to the session for a comprehensive answer.

The stainless steel session will open with papers on "What Is Stainless Steel", "What to Expect of Stainless" and "Special Stainless Steels". The panel, under the direction of R. B. Gunia, will include experts on joining, machining, forming, heat treating and cleaning and finishing.

Other sessions in the Symposium for Steel Users are on Wednesday, Oct. 19, Toolsteels, and on Thursday, Oct. 20, Joining of High-Strength Steels.

T. C. DuMond
American Society for Metals
Metals Park
Novelty, Ohio

I would like to submit the following question(s) to the panel on Fabrication of Stainless Steels at the National Metal Congress:

1.

2.

Name

Title

Address

Ladies Entertainment

Monday, Oct. 17

Luncheon—Bellevue-Stratford Hotel
Burgundy Room (First Floor)

Tuesday, Oct. 18

House Tour—Fairmont Park Area
Luncheon

Wednesday, Oct. 19

Bus Trip to Old Philadelphia
Luncheon
Visit to Franklin Institute and Planetarium

REGISTRATION: Monday, Tuesday, Wednesday
9:00 a.m. to 4:00 p.m.
Ladies Headquarters
Bellevue-Stratford Hotel
Red Room

Ladies Entertainment Committee

Mrs. John B. Giacobbe, Chairman
Mrs. Francis B. Foley, Co-Chairman
Mrs. A. O. Schaefer, Co-Chairman
Mrs. John P. Clark, Jr.
Mrs. Frederick Cooper
Mrs. W. J. Kinderman
Mrs. John E. King
Mrs. Allan Ray Putnam
Mrs. George L. Schiel
Mrs. Charles A. Turner, Jr.
Mrs. E. E. Weismantel

Special Librarians to Study Metallurgy

The American Society for Metals Engineering Institute is cooperating with the Special Libraries Association in providing a two-day course in metallurgical principles, to be held at Philadelphia on Oct. 21-22. Attendance will be limited. If interested, please write to: Mrs. Katherine Faber, International Nickel Co., 67 Wall St., New York, for full information.

Indian Symposium

A symposium on the production, alloying, heat treatment and uses of light metals will be held early in February 1961 by the National Metallurgical Laboratory at Jamshedpur, India.

Members of the American Society for Metals who wish to attend and contribute, or to submit papers in absentia, are invited to write to: B. R. Nijhawan, director of the Laboratory.

Members Asked to Approve Change in Society's Articles of Incorporation

With the dedication of A.S.M.'s new national headquarters at Metals Park on September 14, the principal offices of the Society will officially be moved to that location. Because the move from the old to the new location involved moving from one legal jurisdiction to another, it becomes necessary to change Article Two in the A.S.M. Articles of Incorporation. Such a change must be approved by the Society membership. Therefore, at the Society's annual meeting on Wednesday, Oct. 19, 1960, at the Bellevue-Stratford, Philadelphia, the following resolution will be presented to the membership:

RESOLVED, that the Articles of Incorporation of American Society for Metals be and the same hereby are amended, by striking out the Second Article thereof in its entirety, and by inserting, in lieu of said Second Article, a new Article reading as follows:
The place in this state where the principal office of the corporation shall be located is Russell Township, Geauga County, Ohio.

RESOLVED FURTHER, that the President and Secretary of American Society for Metals be and they hereby are authorized and directed to execute and file in the office of the Secretary of State of the Sate of Ohio a certificate setting forth a copy of this resolution, and to execute, deliver and file any other certificate or instrument which they may deem necessary or appropriate to carry out the purpose and intent of this resolution.

A Metallurgist in Japan

A LARGE TURNOUT OF Golden Gate members enjoyed a "change of pace" during which W. H. Rice, Electric Steel Foundry Co., presented his "Observations of a Metallurgist in Japan".

Dr. Rich spent several months in Japan assisting in the installation of high alloy castings in petrochemical plant equipment. He noted that many Japanese industrial practices are linked closely to the high population density of the country. Because of competition, jobs are highly prized and turnover is almost negligible. To allow younger men to move into industry, retirement at age 55 is compulsory. On retirement, workers receive a lump sum rather than regular payments. Although much of Japanese industry is thoroughly modernized, manual labor remains widespread because of extremely low wages. Unskilled laborers receive from 80-90¢ per day.

Wire and Alloy Tape Used in Electronic Device

ONE OF THE MORE interesting uses of metals in electronics, according to Morris Tenenbaum, Bell Telephone Laboratories, is the twister used extensively in computor technology. The new device was described during a talk on "Metallurgy and Electronics" given before the Washington Chapter. The speaker is head of research in the crystalline state at Bell Laboratories.

The twistor represents a new application of metals in computors. Dr. Tanenbaum described the basic elements of the twistor as a copper wire, 0.005-in. in diameter, around which is wrapped a spiral of magnetic alloy tape. The tape is made of Moly-Permaloy and is approximately 0.004 in. wide and 0.0005 in. thick.

The composite wire with its copper core and helical winding of magnetic alloy permits the storage of information by changing the state of magnetization of the magnetic tape. This permits the twistor to be used as the memory organ in an electronic computor. The principal advantage of the twistor over other devices is its economy of fabrication.

The twistor highlights a metallurgical problem common to most metals used in electronic applications. In the twistor the magnetic properties of the tape must be extremely uniform. Thus the chemical composition and mechanical fabrication of the composite wire must be controlled to an extremely high degree of reproducibility.

Other research work being done at Bell Laboratories was described by Dr. Tanenbaum. One project is directed at understanding the electronic structure of copper through studying electrical properties of single crystals of copper at temperatures near absolute zero. Through these studies it is hoped that electrical properties of new copper alloys can be predicted with much greater accuracy than is now possible.

The speaker also told how new processes for the preparation of nickel with extremely high purity has made possible the development of vacuum tubes with high service reliability. *(Reported for Washington by R. E. Lyons.)*

Mechanical Properties of Intermetallic Compounds

TWO MAJOR FACTORS which contribute to the strength of intermetallic compounds are ordering and the size of the antiphase domains. These compounds are ordinarily ordered at room temperature and in those cases where disordering occurs at high fractions of the melting point, the material softens. The highest strength is attributed to a critical domain size and the variation of strength with temperature is related to the domain size.

John H. Westbrook, General Electric Research Laboratory, speaking on "Intermetallic Compounds and Their Mechanical Properties" at Oak Ridge, presented experimental data which showed that the strength is always associated with the lattice defect concentration. At low temperatures these defects impede the slip process. At high temperatures, where deformation is diffusion controlled, the vacancies accelerate the deformation rate and the material is weak relative to the stoichiometric composition.

One severe limitation of the applicability of intermetallic compounds is their low ductility. Several cases were illustrated where a third component had increased the ductility in these compounds. Dr. Westbrook is currently studying the effect of ternary additions and hopes that he will be able to combine the good high-temperature strength of intermetallic compounds with adequate ductility to yield more attractive materials. *(Reported by H. E. McCoy.)*

W. L. Holshouser, Morris Tenenbaum and Henry E. Frankel Discuss Mr. Tenenbaum's Talk on "Wire and Alloy Tape Used in Electronic Devices" at a Washington Meeting

Modern Methods of Metal Analysis

CONTROL OF COMPOSITION is an integral part of all aspects of metallurgical processes, whether it be in the extraction of metals from their ores, the production of alloys or the utilization of metals. To keep abreast of ever-increasing demands for higher production rates and better quality, improvements in methods of composition analysis have been necessary. These improvements have been successfully accomplished by the use of spectrographic instruments. Because of their ability to provide accurate results within minutes rather than the hours or days characteristic of former methods, "in process" composition control has become a reality. As a direct result, vast improvements in economy of operation and quality of product have been achieved.

C. A. Waggoner, Pacific Naval Laboratory, pointed out in a talk on "Modern Methods of Metal Analysis", at a meeting of the Vancouver Island Chapter, that three stages are evident in the transition to spectrographic methods of composition control in the metallurgical industries. The first stage was the gradual adoption of the optical spectrograph, which occurred between and during the two World Wars. Then, in 1948, the X-ray spectrograph became available commercially and has since gained wide acceptance for metallurgical control. Finally, at the present time, the vacuum spectrometer promises to fill some of the gaps left by the other two instruments.

Spectrographic methods are based on the fact that metal atoms emit characteristic optical or X-ray spectra, depending respectively on whether an electrical discharge or an X-ray beam is used as the exciting source. The occurrence of certain lines in a spectrum serves to establish the presence of a metal, and under carefully controlled conditions, the intensity of a selected line can be a measure of the percentage of a metal in an alloy. Initially, spectra were recorded only photographically, and the rather lengthy process of measuring and evaluating line intensities limited the usefulness of spectrography in metallurgical control. Most present-day instruments, however, measure spectral line intensities by electronic methods which are substantially faster and more accurate. As a consequence, literally millions of determinations are made annually in some industries, and with fewer personnel.

Each of the instruments has its place and, to a large extent, complements the other. Optical spectrography is especially useful for minor alloy constituents in amounts less than about 5%, while X-ray spectrography is more useful for higher percentage constituents and is thus more readily adaptable to complex alloy systems such as stainless steels. Also, certain elements may be handled by one instrument and not by the other. In the analysis of steel, for example, small percentages of boron are determined by optical spectroscopy but cannot be detected by the X-ray method. The vacuum spectrometer is especially useful for the carbon and sulphur determinations which are so important in the manufacture of steels.

The speaker concluded by discussing the role of such instruments in metallurgical research, with reference to corrosion problems, segregation studies, surface film analysis and trace element analysis as related to current developments in the production of ultra-pure metals. *(Reported by W. G. McIntosh.)*

Metals Applied in Aircraft and Missiles

ONLY A SMALL FRACTION of total metal consumption is utilized for aircraft and missiles, but the bulk of modern metallurgical research is directed toward the application of metals in this field. With this thought, Charles Evans, vice-president, technology, Universal Cyclops Steel Co., the panel moderator, introduced a panel discussion on "The Use of Aluminum, Titanium and Steel in Aircraft and Missiles" to the Pittsburgh Chapter.

Carrying the ball for aluminum, Kirby Thornton, manager of Alcoa's Development Division, underscored the fact that aluminum is still the accepted structural material for aircraft and missiles despite today's emphasis on ultra-high-temperature materials. Aluminum alloys, such as Alcoa 7178, are extensively employed for their inherently high strength-weight ratio, low density, ability of suppliers to fabricate large sections, workability, machinability and freedom from residual stress. Mr. Thornton illustrated aluminum's versatility with examples ranging from the handling of cryogenetic materials with conventional alloys to elevated temperature service utilizing Alcoa aluminum powder metallurgy products (APMB).

With the aid of several colorful projected charts, Walter Finley, director of research, Crucible Steel Co., cited numerous advantages of titanium including its virtual chemical indestructibility and reliability at temperatures from —425°F. to short periods at 1200°F. The price of titanium has dropped 31% in the last decade and now competes favorably in price with the more "exotic" ferrous materials. Titanium finds wide usage in space vehicles as pressure vessels, solid fuel cases, rocket motor cases and in aircraft as airframe parts, rip stoppers and jet engine parts.

The role of the semi-austenitic and precipitation hardening stainless steels in aircraft and missiles was discussed by Ray Lula, chief research metallurgist for Allegheny Ludlum Steel Corp. Properties as high as 280,000 psi. tensile, 250,000 psi. yield strength and 14% elongation at 1000° can be developed in AM 357 steel, while the metallurgy of precipitation hardening 15-7 stainless steel, which has a tensile strength of 170,000 psi. at 1100°F., is compatible with the heat treatment cycles required for brazed honeycomb structures. The recent flow turning technique for forming precipitation hardening stainless steels has produced ductile rocket cases with a tensile strength of 270,000 psi.

The panel discussion was completed with an entertaining talk by George A. Roberts, vice-president, technology, Vanadium Alloys Steel Co. and Past National President A.S.M., on use of toolsteels in aircraft and missiles. Forged aircraft parts as large as 7 x 14 ft. are now being designed in toolsteel. Vacuum melting of toolsteels has markedly improved their transverse ductility and CVM (vacuum melted) toolsteel has the highest fatigue strength of any ferrous material at a stress level of 240,000 psi. Dr. Roberts forecast that increasing amounts of toolsteel will be utilized in aircraft and space vehicle construction as speeds go beyond Mach 2 and 3. *(Reported by Edmund C. Franz.)*

Chapter Briefs

Chromium plating is becoming an increasingly useful technique because chromium, probably more than any other metal, has a unique combination of properties, including hardness, coefficient of friction and expansion, high melting point and resistance to heat, density, internal stress, chemical resistance, and resistance to abrasion or wear, oxidation or tarnish. It has high reflective power and electrical resistivity as well as nongalling and nonwetting effects. John W. Babcock, Industrial Hard Chrome Plating Co., in a talk before the **Santa Clara Valley Chapter,** also mentioned certain limitations of chromium plating, including its throwing power, and the amount of equipment as well as expert technique and experience required for its utilization.

Embrittlement or lack of ductility becomes a major problem with many constructional metals at very low temperatures, whereas it is desirable to have ductility for uniform stress distribution. R. M. McClintock, National Bureau of Standards, speaking at **Rocky Mountain Chapter,** also pointed out that face-centered-cubic metals, such as aluminum and austenitic stainless steels, retain relatively high percentages of their ductility at low temperatures while certain body-centered-cubic metals, such as carbon and low-alloy steels, become very brittle. Teflon is the only plastic known to possess any ductility at low temperatures.

The electron bombardment technique is the first process developed that can be depended upon to give vacuum-tight welds in aluminum, that can weld tungsten, molybdenum, ceramics and other materials that are normally impossible or very difficult to weld, and is able to utilize up to 90% of the developed heat in the workpiece. Although more expensive than other techniques, it provides far superior quality. T. H. Crane, chief metallurgist, High Vacuum Equipment Corp., speaking in **Baltimore,** predicted that the future progress of the electron bombardment technique depends strongly on the development of tooling capable of utilizing its benefits.

Ceramic coatings, which have allowed the substitution of coated low-carbon steels for some alloys and stainless, also made it possible to conserve strategic critical materials during the Korean War. John V. Long, Solar Aircraft Co., speaking on "Ceramic Coatings and Techniques for Protecting Metals" before the **Utah Chapter,** pointed out that the major growth in ceramic coating technology has taken place during the last 13 years.

A tour of Chrysler Corp.'s engine plant in Detroit, Mich., was enjoyed by 72 members, students and guests of the **Western Ontario Chapter.** Most comments concerned the high volume of production in automation observed during the tour.

A.I.M.E. Requests Papers

J. B. Newkirk, Research Laboratory, General Electric Co., and J. H. Wernick, Bell Telephone Laboratories, are organizing a technical session on the subject "Direct Observations of Imperfections in Crystals" for the annual meeting of the Metallurgical Society of A.I.M.E., to be held in St. Louis, February 1961. They would like papers pertinent to this session to be submitted to them for consideration. The papers should be concerned with unpublished research. Presentation time will be 10 min. and 5 min. will be allowed for discussion.

Abstracts of 500 words or less should be sent to Dr. Newkirk at P.O. Box 1088, Schenectady, New York, before Oct. 1, 1960. In submitting the abstracts, authors should state whether a written version of their paper can be submitted before Feb. 1, 1961, for possible publication in a unified form.

Donate A.S.M. Film

A.S.M. Past President Clarence Lorig Presents a Copy of the Society's Film, "How Metals Behave" to Jerrold D. Karshner, Columbus Public School System. The film is one of a series to be shown on WOSU-TV in science classrooms next fall. Local chapters of four national technical societies contributed to its purchase

Role of Carbon in Martensitic Steels

THE STRENGTH OF MARTENSITIC steels is achieved primarily with the use of carbon. Carbon in interstitial solid solution in martensite more effectively raises the yield and ultimate tensile strengths than any other element. Ductility and toughness, however, are inversely related to the carbon content of hardened steels. It seems clear that the current design of martensitic ultra-high-strength steels by control of chemical composition and heat treatment results in a compromise between strength, ductility and toughness. It appears probable that if large increases in strength are to be achieved in the future, new means of obtaining strength without further sacrifice in ductility must be explored. That is, strengthening without additional increases in carbon content. The mechanical-thermal processing technique known as the "Ausform" process would appear to be one such method.

"Ausform" was defined by Duane J. Schmatz, Ford Motor Co., at a Chicago meeting, as the plastic deformation of metastable austenite in the "bay" area between the pearlite and bainite transformation bands followed by subsequent transformation to martensite. This "bay" in the isothermal transformation diagram is obtained by the addition and balance of elements such as chromium and nickel which greatly stabilize the austenite and thereby allow sufficient time for severe deformation.

The successful application of the "Ausform" process is seen to be dependent on the extremely close control of time, temperature and energy input during deformation. Control of these variables is most imperative in retaining a fully austenitic structure and, subsequently upon transformation, a completely martensitic structure.

The strength of all "Ausform" steels is proportional to the degree of deformation. At a carbon content of 0.30%, 50% deformation is equivalent in terms of strength parameters to an additional 0.15% carbon.

The greatest strength of "Ausform" steels is attained with the use of relatively high carbon content and maximum austenite deformation. To illustrate this, a steel containing 0.60% carbon deformed 93% had a yield strength of 405,000 psi. and an ultimate tensile strength of 475,000 psi.

Properties of these steels are closely related to microstructures. Electron and optical micrographs reveal a refinement of the martensite in these steels compared to their conventionally treated counterparts. Generally a refinement by at least a factor of three is found.

There are several plausible explanations which might be invoked to describe how cold working austenite may limit the martensite plate size. For example, the number of martensite nucleation sites may be greatly increased, very heavily worked slip bands may block the progress of advancing martensite plates and greatly elongated austenite grain boundaries may become more effective in limiting the size of the martensite plates.

Since refinement of the martensite has been observed to be coincident with increases in tensile strength, the probability that the increase in strength may have been caused directly by the refinement must be considered.

Many correlations between size and strength have been noted in various materials. The strength of a number of "Ausform" steels was shown to be proportional to the reciprocal of the square root of the martensite plate length.

The "Ausform" process is one illustration of the new type of approach that must be used in the development of high-strength materials. *(Reported by W. L. Meinhart for the Chicago Chapter.)*

Education for an Age of Science

TODAY IS TRULY AN AGE OF SCIENCE, an age when scientific discoveries are frequent and progress is phenomenal. Such an age requires a great many more highly trained scientists, engineers and technicians than we now have.

In a talk on "Science Education Today", G. P. O'Connell, assistant manager, educational relations section, General Motors Corp., told members of the Saginaw Valley Chapter that, at the turn of the century, the general average was one engineer for every 250 employees. Today the ratio is around 1 to 50 and in some industries even greater, indicating the fact that we will continue to require highly trained and competent scientists and engineers, as well as many skilled technicians, if we are only to maintain our present standards and keep pace with our increasing population.

The problems of the future, however, cannot be overcome by the sheer weight of numbers but only by the hard work and application of many highly trained minds in the many fields of human effort, including those in science and engineering.

To identify and train competent people to fill these positions in the years ahead is one of our principal problems today—the kind and quality of the educational opportunities we provide our youth is important—equally so is the guidance and counseling we give our students.

The Census Bureau reported recently that the number of elementary school children in the 5 to 13 age bracket from 1950 to July 1959 rose 46%, a jump from 22,180,000 to 32,388,000. The total population rose by 26,000,000 in the same period to 177,103,000. Youngsters in the preschool age range increased from 16,200,000 in 1950 to 19,800,000 in 1959. Children are now entering the school age category at the rate of 4,000,000 a year.

The task of educating our youth is tremendous. Today greater emphasis is being placed on science education, especially at the junior and senior high-school level, than ever before. The U.S. Office of Education reports that we are currently spending between 50 to 60 million dollars a year to improve science education. The enrollments in science at the college and university level have also been increasing.

The National Science Foundation reports that its Institutes provided some 16,000 high school and 2000 college teachers an opportunity for additional study in the sciences this summer. The Physical Science Study Committee reported that in 1959 their new physics program was presented in some 270 high schools to about 12,500 high-school students. Last year the Michigan Curriculum Study Committee for science and mathematics sponsored a series of one and two-day workshops for elementary and secondary science teachers. These are just a few examples of the work educators are doing to give our youth the best science education possible. Industry, through scholarships, as well as in other ways, is working cooperatively with educators towards the same goal.

For the past several years General Motors has had a summer program for high-school physical science and mathematic teachers in many of its plant cities. Through this program over 100 science teachers have been provided summer employment in jobs related to the subjects they teach.

With all the interest in science education on the part of educators, industry and other groups, it is hoped that teachers will be able to provide as many of our American youth as possible with a sound grounding in the basic laws and principles of science and mathematics, give them the best career guidance and counseling available and develop in them good study habits.

Science is knowledge and knowledge is opportunity—each grows upon the other and, if we learn to use our opportunities wisely, science offers truly unlimited horizons.

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Glenn Lattin, Standing Left, Receives an "Honorary M.E.I. Faculty Member" Certificate for Teaching a Course in "Heat Treatment of Steel" at Golden Gate From Ben Berlien

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POSITIONS OPEN

East

METALLURGICAL ENGINEER: Internationally known manufacturing organization desires graduate with one to five years experience for expanding staff metallurgical consulting group. Unusual opportunity for varied assignments in fields of corrosion, contamination, weldability, machinability, wear, fatigue, fabrication, process development, etc. Aptitude for report writing and personal contact work essential. Upstate New York location. Send complete resume. Box 9-5.

RESEARCH METALLURGIST: Opportunities at all levels for research and development with young, aggressive, rapidly expanding organization. Present areas of interest include refractory metals, ceramics and electronic device materials. Write to: Personnel Dept., Materials Research Corp., 47 Buena Vista Ave., Yonkers, N.Y.

TEACHING AND RESEARCH, METALLURGY-SOLID STATE SCIENCE: Expanding graduate program. Offers unusual opportunity for Ph.D. physical metallurgist and/or solid state scientist. Academic rank and salary dependent upon qualifications. Apply: James A. Luker, Chairman, Dept. of Chemical & Metallurgical Engineering, Syracuse University, Syracuse, N.Y.

West

RESEARCH METALLURGIST: Challenging opportunities in combined contract research: teaching assignments in physical, nuclear and structural metallurgy and ceramics. Ph.D. desirable, but outstanding M.S. individual will be considered. Salaries open. Resumes should give academic and professional experience in detail. Send to: Metallurgy Division, University of Denver, Denver 10, Colo.

POSITIONS WANTED

METALLURGICAL ENGINEER: B.S., age 26, married, veteran. Desires work in production and quality control, preferably in steel. Desires to locate in the Northern U. S. (or Northeast). Will relocate. Resume on request. Box 9-10.

SCIENTIST-BUSINESSMAN: Young executive combining successful scientific and business training. Ph.D. with 15 publications in the field of metals, electronic materials and semiconductors. M.B.A. with a strong accomplishment record as million-dollar-manager with large electronic company. Seeks top role in engineering, manufacturing or management consulting. Box 9-15.

METALLURGIST: Age 28, M.S. in metallurgy (high academic achievements) and B.S. in physics. Two years experience in steel mill practice and two years research experience at university. Desires suitable position in Canada. Resume on request. Box 9-20.

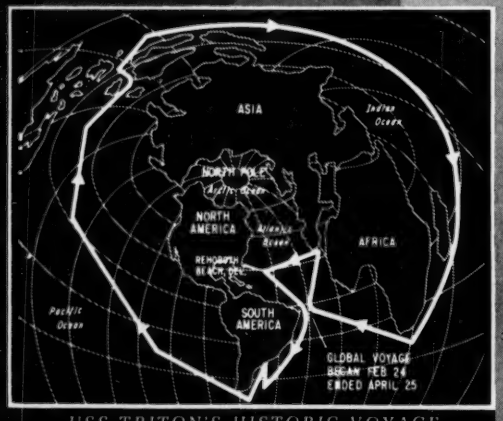
METALLURGICAL ENGINEER: B.Met.E., graduate studies, age 25, single. Four years aircraft and steel experience: Background in material application, development, evaluation and failure analysis. Desires responsible position in development, production or quality control group, preferably in Northeast. Resume on request. Box 9-25.

RESEARCH AND DEVELOPMENT: Eight years experience in alloy development, four years on refractory alloys for nuclear applications including arc smelting, vacuum treatment, powder metallurgy and protective coatings for high-temperature oxidation; four years on foundry alloys including ductile cast iron, stainless steel and shell molding. B.S. and graduate courses, age 32, location East. Box 9-30.

DEVELOPMENT MANAGER OR TECHNICAL EXECUTIVE: Excellent background in research and manufacturing metallurgy covering both ferrous and nonferrous products. Expert in heat treatment, machining and fabrication practices, welding, joining, coatings, etc. Also excellent background in steel processing practices, foundry and toolsteels. Top level laboratory supervision experience. Prefers Midwest or East. Resume on request. Box 9-35.

CHIEF OR SUPERVISING METALLURGIST: Physical or process. Nine years research and development, production soft magnetic materials; four years supervisor, customer service, technical administration. Seeking line management position embracing research and development, production and sales utilizing specialized experience. Salary open, age 35. Resume on request. Box 9-40.

PHYSICAL METALLURGIST: Receiving Ph.D. in June, 1961. B.S. and M.S. in physical



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NONDESTRUCTIVE TESTING

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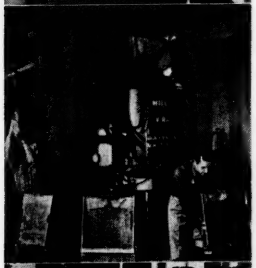

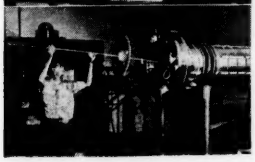

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Los Alamos representatives, registered at the Ben Franklin Hotel, attending the Philadelphia meetings of the Society for Nondestructive Testing, will be happy to talk with interested Physicists, Metallurgists, Physical Chemists and Engineers. Specialized experience desirable but not mandatory.

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chemistry. Four years experience in basic metallurgical research, physical testing and analytical chemistry. Veteran, age 32, married, family. Interested in industrial research with opportunity for advancement to research supervision. Resume on request. Box 9-45.

PHYSICAL METALLURGIST: B.S. and M.S. in metallurgy. Two years research experience with reactor and refractory materials. Desires challenging research position with growing organization. Eastern location preferred. Box 9-50.

PHYSICAL METALLURGIST: B.S. in mechanical; M.S. and Ph.D. in metallurgical engineering, age 38, married, two children. Ten years experience in machine design and heat treatment, six years in fundamental research (X-ray diffraction, preparation of single crystals by various methods, crystal imperfections, plastic deformation, cryogenics, electron band structure of metals and alloys). Desires position in teaching and/or fundamental research in physical metallurgy. Box 9-55.

METALLURGICAL ENGINEER: Age 35, married, veteran, with 8½ years diversified experience in material selection and process control and development work with ferrous and nonferrous metals and alloys. Central U. S. preferred. Box 9-60.

METALLURGICAL ENGINEER: B.S., M.S. degrees, age 32, married. Three years quality control laboratory for forging division including testing, shop problems, failure analysis; four years research mechanical and process section including foundry, testing, gas turbine and joining projects; four years evening instructor in metal processing and metallography; two years quality control department of steel mill. Desires responsible position. Will relocate. Resume on request. Box 9-65.

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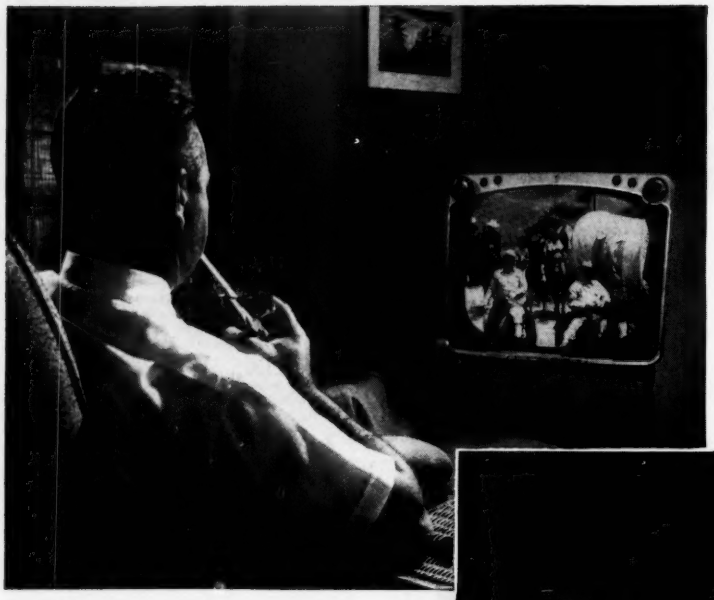
P.O. Box 1462, Reading, Penna.



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METALLURGICAL ENGINEER: Degree from accredited college. Fifteen years diversified metallurgical experience in jet aircraft engine industry. Includes supervision of materials laboratory, shop problem investigations, heat treating, material and process control, evaluation of new materials and processes, training of nondestructive testing personnel. Desires relocation in Philadelphia-Baltimore area. Box 9-70.

PHYSICAL METALLURGIST: B.S. degree, with 12 years experience; four years as plant metallurgist, foundry and heat treating; four years research in high-temperature refractory alloys; four years supervisor product development and applications for super refractory alloys with customer service work. Interested in engineering sales, technical service areas on West Coast. Credited with publications and patents. Present salary $13,000 per year. Box 9-75.

METALLURGICAL DEVELOPMENT: Twenty years background includes extensive individual contributor practice, supervision, metallurgical laboratory installation and research management. Constructional steels, high-temperature alloys, refractory metals and nonferrous engineering materials. Desires to organize and/or head metallurgical services either in product-component development or in metalworking manufacture. Resume on request. Box 9-80.

METALLURGICAL TECHNOLOGIST: Age 29, married, graduate of nondegree technical college. Industrial experience including research and development. Seeks employment in research in area that offers opportunity to complete studies for B.S. degree and continue in graduate work. Wishes a permanent career in research, U. S. or Canada. Box 9-85.

METALLURGIST: M.S. in metallurgical engineering. Six years research and development experience. Two years mechanical properties and transformations work with high-strength and toolsteels. Three years titanium high-temperature alloy development, also some experience with columbium, molybdenum and vanadium bases. One year investigations of metalworking processes. Interested in research and development or general metallurgical work. Western U. S. location preferred. Box 9-95.

CHEMIST-METALLOGRAPHER: B.S. degree in chemistry, age 26, single. Four years experience in aluminum reduction plant. Business management training. Background includes army research and development in active and reserve status. Will relocate anywhere in U.S., prefers South or Southeast. Resume available. Box 9-100.

PHYSICAL METALLURGIST: M.S., Ph.D. degrees. Seven years diversified experience in research and development in the ferrous metal field and in consulting. Five years in responsible supervisory position. Extensive experience in heat treating, nondestructive and destructive testing, metallography, failure analysis, selection and specification of materials and processes, etc. Publications. Seeks new challenge in administrative or technical position. Resume on request. Box 9-105.

METALLURGIST: Some advanced study, age 35, married. Background in ferrous and nonferrous metals, major field in refractory metals and protective coatings. Experience in service failures, specifications and report writing. Well acquainted with fabrication processes, metallography and testing, including heat programing. Desires responsible position with advance potential in central or eastern U. S. Resume on request. Box 9-110.

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METALLURGICAL ENGINEER: B.S. degree, age 33, married, two children. Seven years fabrication experience in nuclear field, including Zircaloy-2 uranium assemblies, oxide power cores, experimental uranium fuel and special uranium parts; 1½ years in extrusion and tube drawing; 2 years at management level. Desires position dealing with a variety of fabrication operations requiring originality and initiative, South or West. Box 9-130.

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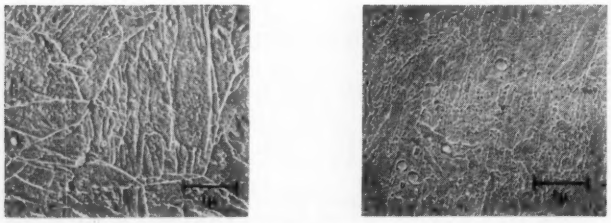
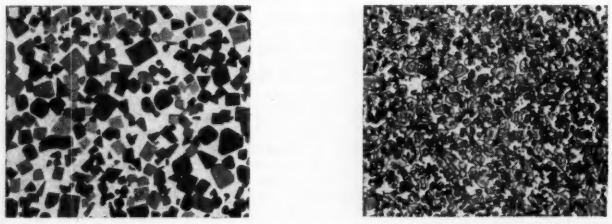
Scientists interested in the nature and properties of surfaces, the deformation of nonmetallic solids, thermodynamics and kinetics, or dislocation theory are especially needed. Basic research is presently being carried on in calorimetry, metal solidification, recrystallization textures, plastic deformation, phase transformations, diffusion, and interfacial energies of solid-solid and solid-liquid systems. A substantial staff of theoretical and solid state physicists is available for consultation and collaboration.



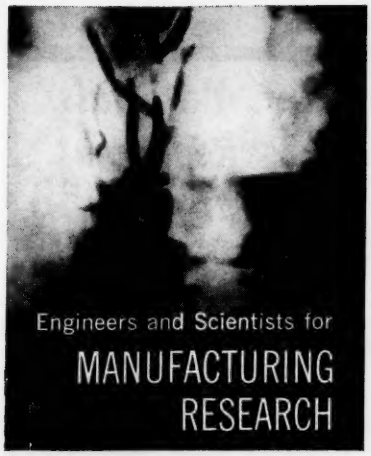
By evoking current knowledge of the effects of plastic deformation on the kinetics of isothermal decomposition, ultra high strength steels with tensile strengths near one-half million psi were developed with as much as eight percent elongation. Electron micrographs at X15000 magnification show conventional (left) and Scientific Laboratory steels (right). Quantitative measurements of the fine martensitic microstructure shown in the new steels correlate with yield and fracture stresses in accordance with theories of brittle fracture.



A basic study of the interfacial energy of liquid metal-solid ceramic substrates had led to the development of new microstructures. Cermets having these microstructures possess unusual properties. Decrease of solid-liquid interfacial energy by compositional control has resulted in TiC-nickel molybdenum bonded cermets which exhibit remarkable cutting tool characteristics. The microstructure on the left (TiC-nickel bonded) demonstrates the structure obtained with partial wetting of the solid by the liquid while that on the right (TiC-nickel molybdenum bonded) exhibits the fine particle size and thin metal film requisite for superior mechanical and cutting tool behavior.

Messrs. Julius Harwood, E. D. Marande, V. F. Zackay, members of our Scientific Staff, will be attending the National Metal Congress.

A resume of education and experience may be sent to any of the above at the Scientific Laboratory, 20000 Rotunda Drive, Dearborn, Michigan.



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In each case the published literature has been carefully assessed, and what are regarded as the most reliable results are presented in a series of diagrams with critical notes and references.

The author has been associated for many years with the Research Laboratories of The British Aluminium Co., Ltd., and has himself been responsible for a good deal of work on the constitution of aluminium alloys.

The monograph is an indispensable reference book for all concerned with aluminium alloys.

Copies may be obtained through booksellers or direct from:

THE INSTITUTE OF METALS
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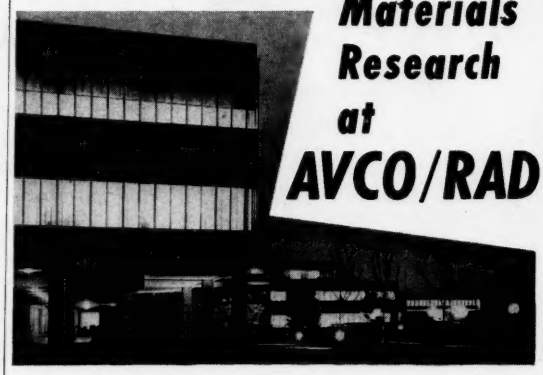

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SOLID STATE PHYSICIST

BS, MS or Ph.D with background in solid state physics or related field to do research on materials at very high temperatures. Electrical conducting and insulating properties are of particular concern. Experience or interest in gaseous discharges helpful. Assignment level commensurate with training and experience.

The division's new suburban location provides an unusually attractive working environment outside of metropolitan Boston from which the universities, theaters, and cultural and medical centers of the city are easily accessible.
Publications and professional development are encouraged, and the division offers a liberal educational assistance program for advanced study.

Outdoor recreational advantages close by are sailing at Marblehead, ocean bathing at Cape Cod and the South Shore, hiking and skiing in the mountains of Vermont and New Hampshire, camping in the woods of Maine, and sightseeing and deep sea fishing along the picturesque coast from Martha's Vineyard to Bar Harbor.

Send resume to Mr. J. E. Bergin
Employment Supervisor

AVCO
Research & Advanced Development
A Division of Avco Corporation
201 Lowell St., Wilmington, Mass

The 15th METALLOGRAPHIC EXHIBIT

Philadelphia, October 17 to 21, 1960

All metallographers—
everywhere—
are cordially invited to
display their best work.

RULES FOR ENTRANTS

Exhibitors do not need to be members of the American Society for Metals.

Work which has appeared in previous metallographic exhibits held by the American Society for Metals is unacceptable.

Photographic prints should be mounted on stiff cardboard, extending no more than 3 in. beyond edge of print in any direction; maximum dimensions 14 by 18 in. (35 by 45 cm.) Heavy, solid frames are unacceptable.

Entries should carry a label on the *face of the mount* giving:

Classification of entry.

Material, etchant, magnification and other desirable data.

A brief statement (if desired) calling attention to any unusual aspect of the entry.

The name, company affiliation and postal address of the exhibitor should be placed on the *back of the mount* together with a request for return of the exhibit if so desired.

Entrants living outside the United States should send their micros by first-class letter mail endorsed "Photo for Exhibition — No Commercial Value — May Be Opened for Customs Inspection".

Exhibits must be delivered before Oct. 1, 1960, either by prepaid express, registered parcel post or first-class letter mail, addressed:

Metallographic Exhibit
American Society for Metals
Metals Park
Novelty, Ohio, U. S. A.

CLASSIFICATION OF MICROS

Class 1. Irons and steels, cast and wrought
Class 2. Stainless steels and heat resisting alloys
Class 3. Aluminum, magnesium, beryllium, titanium and their alloys
Class 4. Copper, nickel, zinc, lead and their alloys
Class 5. Uranium, plutonium, thorium, zirconium and reactor fuel and control elements
Class 6. Metals and alloys not otherwise classified
Class 7. Series showing transitions or changes during processing
Class 8. Welds and other joining methods
Class 9. Surface coatings and surface phenomena
Class 10. Slags, inclusions, refractories, cermets and aggregates
Class 11. Electron micrographs using replicas
Class 12. Electron micrographs (transmission)
Class 13. Color prints in any of the above classes
Class 14. Results by unconventional technique

AWARDS AND OTHER INFORMATION

A committee of judges will be appointed by the Metal Congress management which will award a First Prize (a medal and blue ribbon) to the best in each classification. Honorable Mentions will also be awarded (with appropriate medals) to other photographs which in the opinion of the judges closely approach the winner in excellence. A Grand Prize, in the form of an engrossed certificate and a money award of $500 from the Adolph I. Buehler Endowment will also be awarded the exhibitor whose work is judged best in the show, and his exhibit shall become the property of the American Society for Metals for preservation and display in the Society's national headquarters.

All prize-winning photographs will be retained by the Society for one year and placed in a traveling exhibit to the various Chapters.

42nd NATIONAL METAL CONGRESS & EXPOSITION

Philadelphia Trade & Convention Center——————Oct. 17 to 21, 1960

Nearly everyone in metals will be in Philadelphia October 17

"Because of the time demands of my own job, it is only logical that if I can find one place and one time where I can bring myself up to date on what's new in metals, that's the place I want to be. The 1960 Philadelphia Metal Show will provide a meeting place where I can obtain—through conversation, through exhibits, and attendance of technical sessions—the latest information and engineering data on metals and related materials."

George F. Stradar,
Chief Metallurgist
FAIRCHILD CAMERA & INSTRUMENT CORPORATION

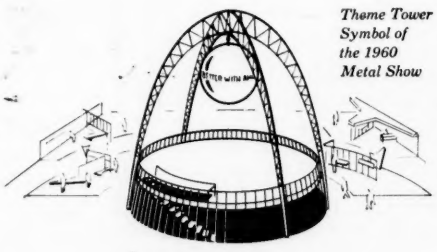
"ASM brings together in one place and at one time the year's most important developments in the technical and practical aspects of the metals industry. Never have I left a show without several ideas for applications of materials, equipment or processes in my engineering work. The 1960 Metal Show promises me more 'take home' than ever."

Raymond J. Hibbeln,
Dept. Chief, Product & Development Engineering
WESTERN ELECTRIC COMPANY

That's how important the 1960 Philadelphia Metal Show will be . . . not only to the recognized leaders but to those on the way up in metals and materials technology. Everyone will look to this event as a vital concentration of the latest thought and achievement. Your participation is a must for keeping technologically up to date, and the Metal Show does meet this need. This year a new emphasis on metals and materials, processes and techniques will be presented by 300 exhibits and 250 technical papers. PLAN NOW TO ATTEND!

"The Metal Show gives me several essentials for my work: science and discussions with scientists through the weekend seminar; science and engineering through the sessions of the several societies; and finally applications of knowledge and know-how to products through the Show. Most valued are the friends and the stimulating discussions with them."

John P. Howe,
Research Director
Atomics International
NORTH AMERICAN AVIATION



Theme Tower Symbol of the 1960 Metal Show

NATIONAL METAL CONGRESS and EXPOSITION

Philadelphia Trade & Convention Center • October 17-21

Sponsored by the AMERICAN SOCIETY FOR METALS *Metals Park • Novelty, Ohio*

Cooperating Activities: The Metallurgical Society of AIME; Society for Non-destructive Testing, Inc. Associations presenting technical sessions in cooperation with ASM: Metal Powder Industries Federation; Metal Treating Institute; Ultrasonic Manufacturers' Association; Industrial Heating Equipment Association; Special Libraries Association—Metals Division; American Society for Testing Materials—Committee B-9; and extensive research and engineering programs of the American Society for Metals, and ASM Seminars.

Show Hours: Monday, Noon - 6 p.m.; Tuesday, Noon - 10 p.m.; Wednesday, Noon - 10 p.m.; Thursday, 10 a.m. - 6 p.m.; Friday, 10 a.m. - 6 p.m.